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World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

1325748

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

May 24, 2005

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: 60/566,148

FILING DATE: *April 27, 2004*

RELATED PCT APPLICATION NUMBER: *PCT/US05/14514*



Certified by

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

042704

17281 U.S. PTO

PTO/SB/16 (01-04)

Approved for use through 07/31/2006. OMB 0651-0032

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EL919129043US

22151 U.S. PTO
60/566148

042704

| INVENTOR(S) | | | | | |
|--|--|---|--|---|--|
| Given Name (first and middle [if any]) | | Family Name or Surname | | Residence (City and either State or Foreign Country) | |
| Rafael | | Garcia | | Tempe, Arizona | |
| Additional inventors are being named on the <u>1</u> separately numbered sheets attached hereto | | | | | |
| TITLE OF THE INVENTION (500 characters max) | | | | | |
| METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED GALLIUM NITRIDE POWDERS | | | | | |
| Direct all correspondence to: CORRESPONDENCE ADDRESS | | | | | |
| <input checked="" type="checkbox"/> Customer Number: <u>28,529</u> | | | | | |
| OR | | | | | |
| <input type="checkbox"/> Firm or Individual Name | | | | | |
| Address | | | | | |
| Address | | | | | |
| City | | State | | Zip | |
| Country | | Telephone | | Fax | |
| ENCLOSED APPLICATION PARTS (check all that apply) | | | | | |
| <input checked="" type="checkbox"/> Specification Number of Pages <u>2</u> | | <input type="checkbox"/> CD(s), Number _____ | | | |
| <input type="checkbox"/> Drawing(s) Number of Sheets _____ | | <input checked="" type="checkbox"/> Other (specify) <u>postcard</u> | | | |
| <input type="checkbox"/> Application Data Sheet. See 37 CFR 1.76 | | | | | |
| METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT | | | | | |
| <input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. | | | | FILING FEE Amount (\$) | |
| <input checked="" type="checkbox"/> A check or money order is enclosed to cover the filing fees. | | | | <div>\$80.00</div> | |
| <input checked="" type="checkbox"/> The Director is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: <u>070135</u> | | | | | |
| <input type="checkbox"/> Payment by credit card. Form PTO-2038 is attached. | | | | | |
| The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government. | | | | | |
| <input checked="" type="checkbox"/> No. | | | | | |
| <input type="checkbox"/> Yes, the name of the U.S. Government agency and the Government contract number are: _____ | | | | | |

Respectfully submitted,

SIGNATURE

TYPED or PRINTED NAME Thomas D. MacBlainTELEPHONE 602-530-8088

[Page 1 of 2]

Date 4/27/2004REGISTRATION NO. 24,583

(if appropriate)

Docket Number: 9138-0156**USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT**

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Provisional Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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PROVISIONAL APPLICATION COVER SHEET
Additional Page

PTO/SB/16 (08-03)

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Docket Number 9138-0156

| INVENTOR(S)/APPLICANT(S) | | |
|---|-------------------|---|
| Given Name (first and middle [if any]) | Family or Surname | Residence (City and either State or Foreign Country) |
| Fernando A. | Ponce | Tempe, Arizona |
| Abigail | Bell | Tempe, Arizona |

[Page 2 of 2]

Number 1 of 1

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FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT (\$) 80

Complete if Known

Application Number 11
Filing Date herewith
First Named Inventor Garcia
Examiner Name
Art Unit
Attorney Docket No. 9138-0156

METHOD OF PAYMENT (check all that apply)

☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number 070135
Deposit Account Name Gallagher & Kennedy, P.A.

The Director is authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☒ Credit any overpayments

☒ Charge any additional fee(s) or any underpayment of fee(s)

☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

| Large Entity | | Small Entity | | Fee Description | Fee Paid |
|--------------|----------|--------------|----------|------------------------|----------|
| Fee Code | Fee (\$) | Fee Code | Fee (\$) | | |
| 1001 | 770 | 2001 | 385 | Utility filing fee | |
| 1002 | 340 | 2002 | 170 | Design filing fee | |
| 1003 | 530 | 2003 | 265 | Plant filing fee | |
| 1004 | 770 | 2004 | 385 | Reissue filing fee | |
| 1005 | 160 | 2005 | 80 | Provisional filing fee | 80 |
| SUBTOTAL (1) | | | | (\$) | 80 |

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

| | | Extra Claims | | Fee from below | | Fee Paid |
|--------------------|----------------------|--------------|----------------------|----------------|----------------------|----------------------|
| Total Claims | <input type="text"/> | -20** = | <input type="text"/> | X | <input type="text"/> | <input type="text"/> |
| Independent Claims | <input type="text"/> | -3** = | <input type="text"/> | X | <input type="text"/> | <input type="text"/> |
| Multiple Dependent | | | | | <input type="text"/> | <input type="text"/> |

| Large Entity | | Small Entity | | Fee Description |
|--------------|----------|--------------|----------|--|
| Fee Code | Fee (\$) | Fee Code | Fee (\$) | |
| 1202 | 18 | 2202 | 9 | Claims in excess of 20 |
| 1201 | 86 | 2201 | 43 | Independent claims in excess of 3 |
| 1203 | 290 | 2203 | 145 | Multiple dependent claim, if not paid |
| 1204 | 86 | 2204 | 43 | ** Reissue independent claims over original patent |
| 1205 | 18 | 2205 | 9 | ** Reissue claims in excess of 20 and over original patent |

SUBTOTAL (2) (\$)

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

| Large Entity | | Small Entity | | Fee Description | Fee Paid |
|--------------|----------|--------------|----------|--|----------|
| Fee Code | Fee (\$) | Fee Code | Fee (\$) | | |
| 1051 | 130 | 2051 | 65 | Surcharge - late filing fee or oath | |
| 1052 | 50 | 2052 | 25 | Surcharge - late provisional filing fee or cover sheet | |
| 1053 | 130 | 1053 | 130 | Non-English specification | |
| 1812 | 2,520 | 1812 | 2,520 | For filing a request for ex parte reexamination | |
| 1804 | 920* | 1804 | 920* | Requesting publication of SIR prior to Examiner action | |
| 1805 | 1,840* | 1805 | 1,840* | Requesting publication of SIR after Examiner action | |
| 1251 | 110 | 2251 | 55 | Extension for reply within first month | |
| 1252 | 420 | 2252 | 210 | Extension for reply within second month | |
| 1253 | 950 | 2253 | 475 | Extension for reply within third month | |
| 1254 | 1,480 | 2254 | 740 | Extension for reply within fourth month | |
| 1255 | 2,010 | 2255 | 1,005 | Extension for reply within fifth month | |
| 1401 | 330 | 2401 | 165 | Notice of Appeal | |
| 1402 | 330 | 2402 | 165 | Filing a brief in support of an appeal | |
| 1403 | 290 | 2403 | 145 | Request for oral hearing | |
| 1451 | 1,510 | 1451 | 1,510 | Petition to institute a public use proceeding | |
| 1452 | 110 | 2452 | 55 | Petition to revive - unavoidable | |
| 1453 | 1,330 | 2453 | 665 | Petition to revive - unintentional | |
| 1501 | 1,330 | 2501 | 665 | Utility issue fee (or reissue) | |
| 1502 | 480 | 2502 | 240 | Design issue fee | |
| 1503 | 640 | 2503 | 320 | Plant issue fee | |
| 1460 | 130 | 1460 | 130 | Petitions to the Commissioner | |
| 1807 | 50 | 1807 | 50 | Processing fee under 37 CFR 1.17(q) | |
| 1806 | 180 | 1806 | 180 | Submission of Information Disclosure Stmt | |
| 8021 | 40 | 8021 | 40 | Recording each patent assignment per property (times number of properties) | |
| 1809 | 770 | 2809 | 385 | Filing a submission after final rejection (37 CFR 1.129(a)) | |
| 1810 | 770 | 2810 | 385 | For each additional invention to be examined (37 CFR 1.129(b)) | |
| 1801 | 770 | 2801 | 385 | Request for Continued Examination (RCE) | |
| 1802 | 900 | 1802 | 900 | Request for expedited examination of a design application | |

Other fee (specify)

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$)

SUBMITTED BY

(Complete if applicable)

Name (Print/Type) Thomas D. MacBlain Registration No. 24,583 Telephone 602-530-8088
Signature [Signature] (Monyv/Agent) Date 4/27/2004

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Garcia et al.

Filed: Herewith

Title: **METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED GALLIUM
NITRIDE POWDERS**

CERTIFICATE OF MAILING BY EXPRESS MAIL
"Express Mail" mailing label number EL919129043US

Mail Stop Provisional Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

I hereby certify that the following correspondence is being deposited in the United States Postal Service as Express Mail on the date shown below in an envelope addressed as shown above.

1. Provisional Application for Patent Cover Sheet (2 pages);
2. Fee Transmittal for FY 2004 (1 page in duplicate);
3. Specification (2 pages plus cover sheet);
4. Check for \$80.00; and
5. A return receipt postcard.

4/27/04
Date

Suzanne Shields
Suzanne Shields

GALLAGHER & KENNEDY, P.A.
2575 East Camelback Road
Phoenix, Arizona 85016-9255
Tel. No. (602) 530-8000
Fax. No. (602) 530-8500

Express Mail Label No. EL919129043US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Provisional Patent Application

Title: **METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED
GALLIUM NITRIDE POWDERS**

Inventor(s): Rafael Garcia, Tempe, Arizona
Fernando A. Ponce, Tempe, Arizona
Abigail Bell, Tempe, Arizona

Attorneys for Applicant: Thomas D. MacBlain
Donna H. Catalfio
Gallagher & Kennedy, P.A.
2575 East Camelback Road
Phoenix, AZ 85016-9225

METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED GALLIUM NITRIDE POWDERS

The problem which this invention solves is:

1. Low quality in n-type gallium nitride powders; and
2. Doping and co-doping GaN-powders for electroluminescent devices.

We have developed a new method to produce silicon-doped gallium nitride powders.

This method has a high control over the concentration of silicon in the final product. The method consists in reacting a gallium-silicon alloy with ultra-high purity ammonia in a horizontal quartz tube reactor at 1200°C curing 1.5 hours.

The gallium-silicon alloy is prepared using a mechanical mixer. Ultra-high purity gallium melt and silicon powder are placed in a stainless steel sealed vessel under vacuum at a selected temperature (e.g. 500°C) and the vessel is mechanically mixed for several hours in order to produce a highly homogeneous alloy. A variant to this invention is to place the gallium melt in contact with a silicon crystal (like the melt on top of a silicon wafer, or dipping a silicon crystal on the melt) and increasing the temperature to a value that results in the desired solubility of silicon (according to the Ga-Si phase diagram). The gallium-silicon alloy is then removed and reacted as previously described. An ultrasonic agitator may be used to accelerate the solubility process.

We have been working on the synthesis of gallium nitride and related compounds as part of a GaN microcrystalline powder project supported by a gift from Durel Corporation (now a division of Rogers Corporation). Professor Fernando A. Ponce and I (Rafael Garcia) planned my second year of postdoctoral stay at Arizona State University (ASU), this second year with the emphasis on learning how to dope such GaN powders. This work is of high scientific as well as technological importance. Durel's gift allowed us to explore directions which were not mainstream to current technology. The importance of these powders is in their potential as electroluminescent phosphors. The first stage involved production of GaN powders with high crystalline quality and high light emission efficiency. The second stage involved learning to dope such powders. We started with a new series of experiments using silicon as a donor agent and we found that it is possible to produce silicon doped gallium nitride powder using a gallium-silicon alloy as a precursor. We also found that through this method it is possible to control the

concentration of silicon in the gallium nitride powders. The material produced resulted in surprisingly high silicon-related luminescence.

This invention can be used as a method to produce n-type doped phosphors that could be used as active material in electroluminescent devices.